FIG. 1

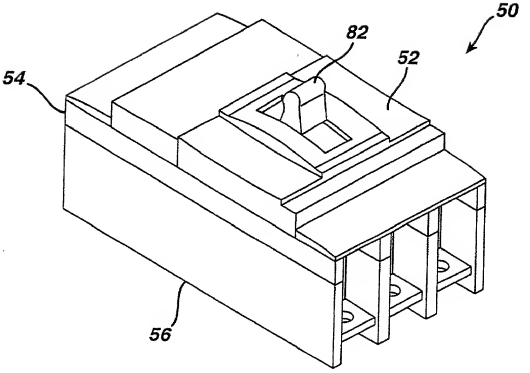
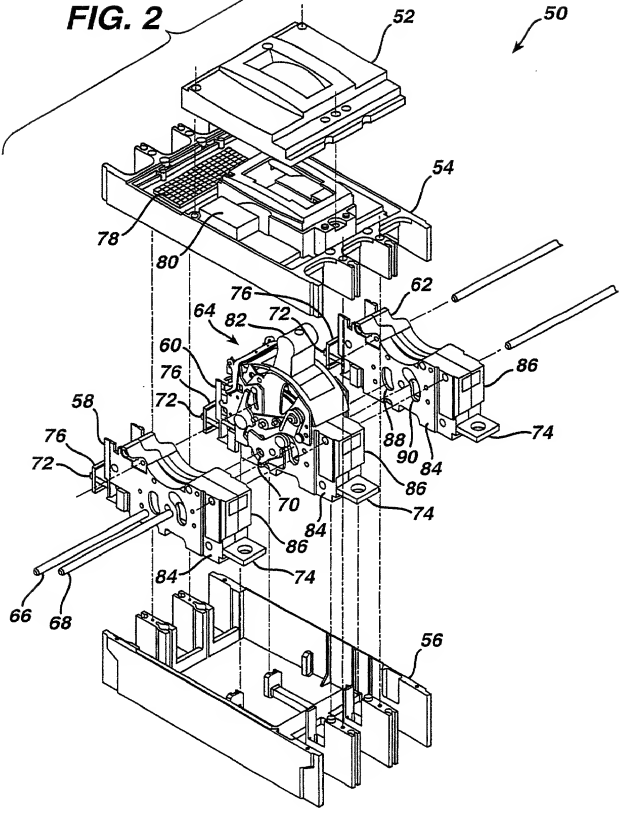


FIG. 2



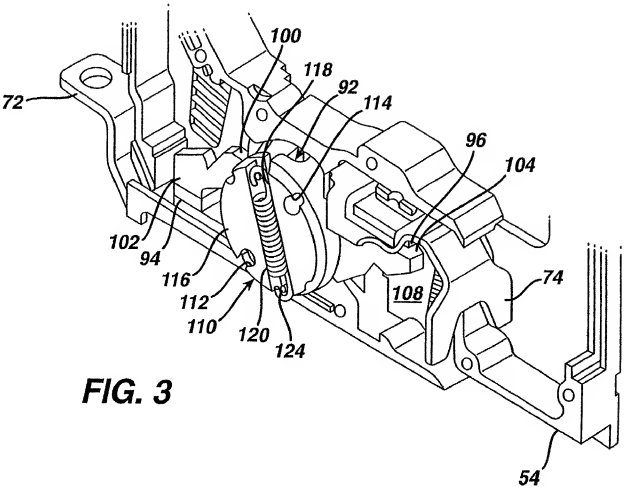


FIG. 3

FIG. 4

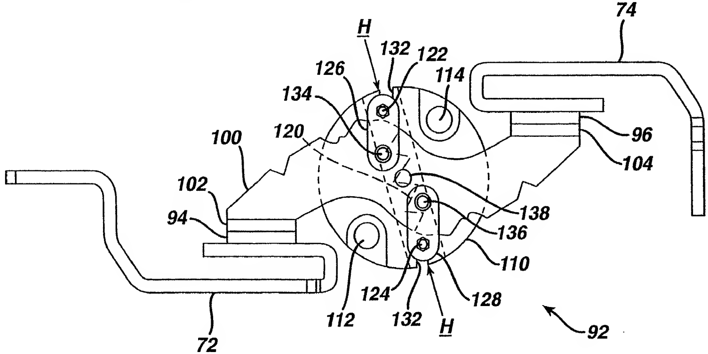

74
H
132
122
126
114
134
100
120
96
104
102
94
138
136
110
124
128
112
132
H
92
72

FIG. 5

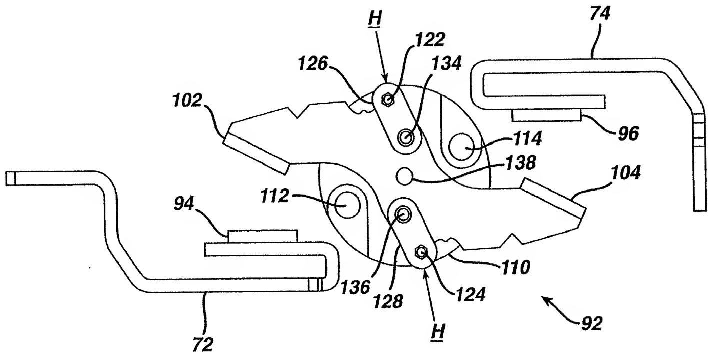


FIG. 6

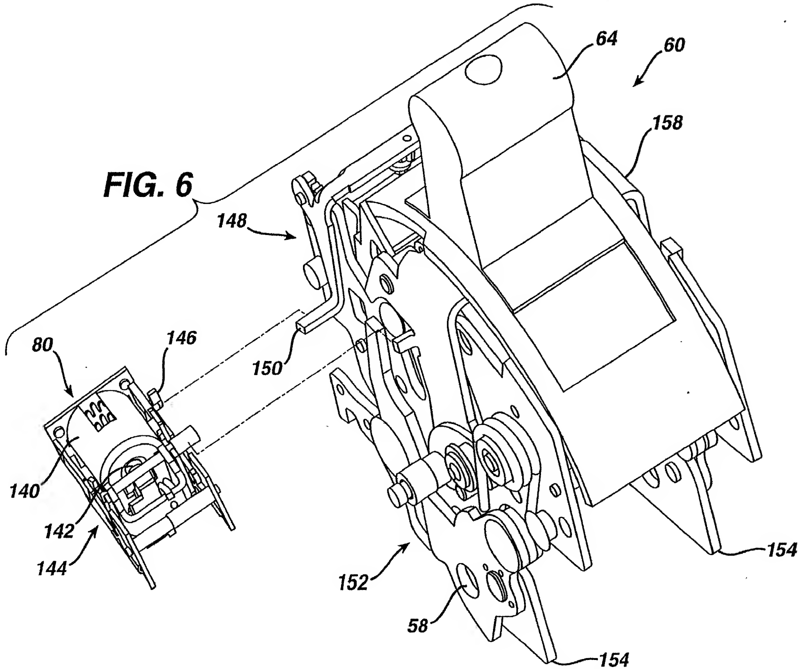


FIG. 7

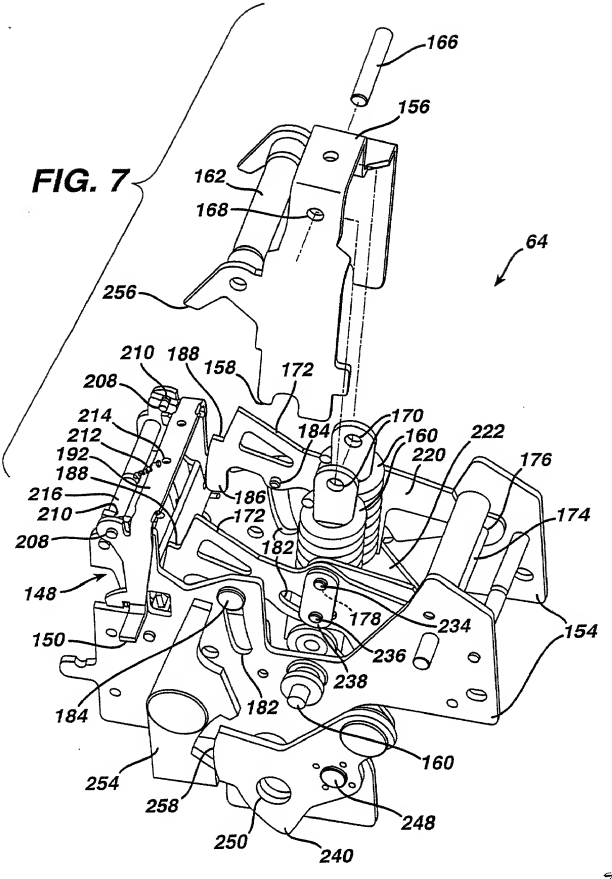
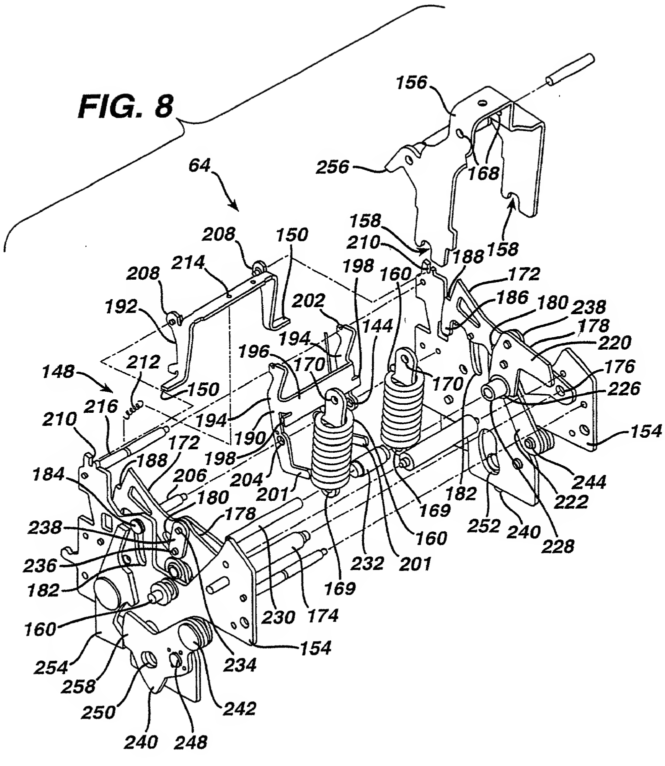

166
156
162
168
64
256
210
188
158
172
208
214
212
192
188
216
210
208
148
150
184
254
258
250
240
170
184
160
222
220
176
174
186
172
182
178
234
154
236
238
182
160
248

FIG. 8



64
156
256
168
158
158
210
188
208
150
214
208
192
198
160
172
186
180
238
178
220
202
144
194
196
170
170
176
226
148
212
150
216
210
194
190
172
198
188
184
206
204
201
180
178
238
236
182
160
154
182
244
222
169
240
252
228
160
232
201
169
230
174
254
258
250
240
248
242
234
154

FIG. 9

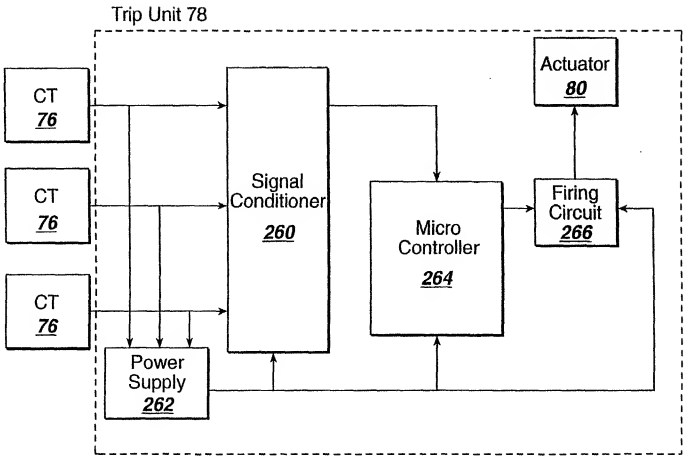


FIG. 10 Circuit Breaker Modeling Flowchart

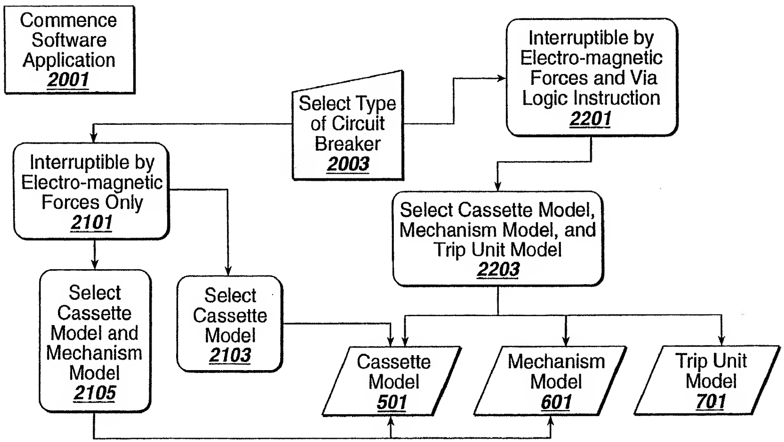


FIG. 11

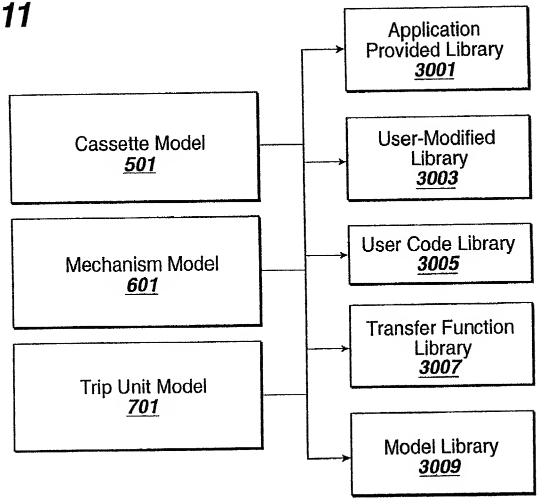
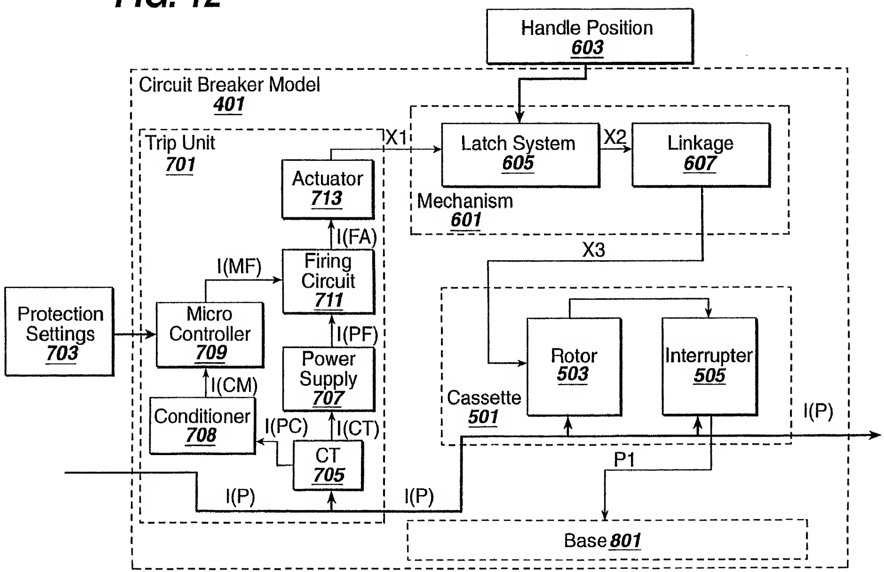

Cassette Model
501
Mechanism Model
601
Trip Unit Model
701
Application
Provided Library
3001
User-Modified
Library
3003
User Code Library
3005
Transfer Function
Library
3007
Model Library
3009

FIG. 12



Handle Position
603
Circuit Breaker Model
401
Trip Unit
701
X1
Latch System
605
X2
Linkage
607
Actuator
713
Mechanism
601
I(FA)
X3
I(MF)
Firing
Circuit
711
Protection
Settings
703
Micro
Controller
709
I(PF)
Power
Supply
707
Rotor
503
Interrupter
505
I(CM)
Cassette
501
Conditioner
708
I(PC)
I(CT)
I(P)
CT
705
P1
I(P)
I(P)
Base 801

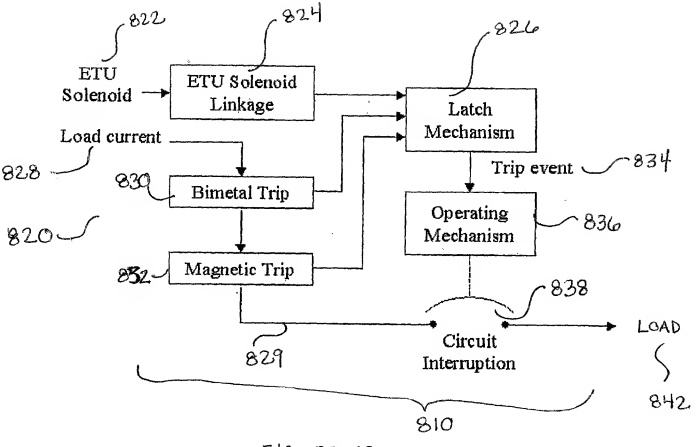


FIGURE 13

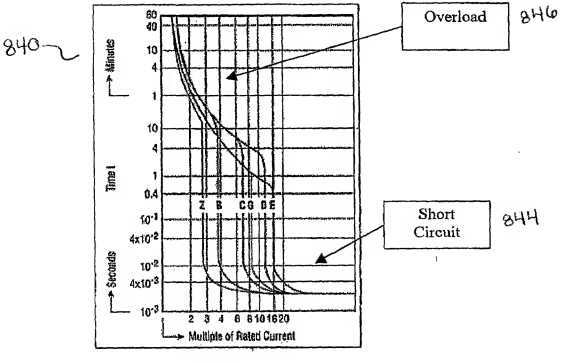


FIGURE 14

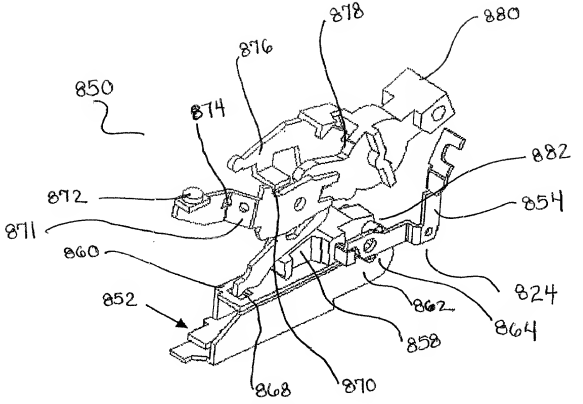


FIGURE 15

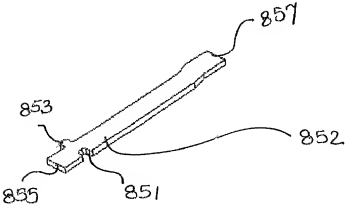


FIGURE 16

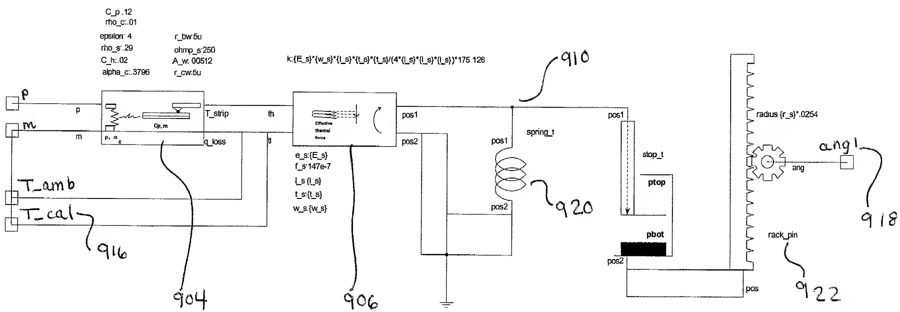

C_p .12
rho_c:.01
epsilon 4
rho_s .29
C_h:.02
alpha_c:.3796
r_bw 5u
ohmp_s 250
A_w 00512
r_cw 5u
p
m
T_amb
T_cal
916
904
T_strip
q_loss
th
Cp, m
k:{E_s}*{w_s}*{l_s}*{t_s}*{t_s}/(4*{l_s}*{l_s}*{l_s})*175 126
Effective thermal force
e_s:{E_s}
f_s 147e-7
l_s {l_s}
t_s:{t_s}
w_s {w_s}
906
pos1
pos2
910
spring_t
920
stop_t
ptop
pbot
radius {r_s}*.0254
ang
ang1
918
rack_pin
922
pos

FIGURE 17

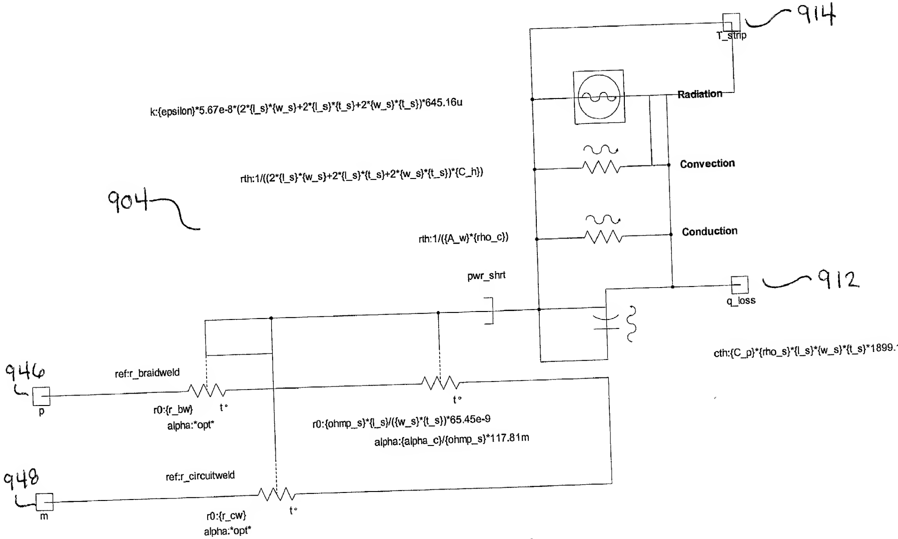

914
T_strip
Radiation
Convection
Conduction
912
q_loss
k:{epsilon}*5.67e-8*(2*{l_s}*{w_s}+2*{l_s}*{t_s}+2*{w_s}*{t_s})*645.16u
rth:1/((2*{l_s}*{w_s}+2*{l_s}*{t_s}+2*{w_s}*{t_s})*{C_h})
904
rth:1/({A_w}*{rho_c})
pwr_shrt
cth:{C_p}*{rho_s}*{l_s}*{w_s}*{t_s}*1899.1
946
p
ref:r_braidweld
r0:{r_bw}
alpha:*opt*
t°
r0:{ohmp_s}*{l_s}/({w_s}*{t_s})*65.45e-9
alpha:{alpha_c}/{ohmp_s}*117.81m
948
m
ref:r_circuitweld
r0:{r_cw}
alpha:*opt*

FIGURE 18

906

```
values {
    deltaT = tc(th) - tc(tl)
    Pout = F_s*deltaT*E_s*w_s*t_s*t_s /
           (4 * l_s) * 4.24358
}
equations {
    # no input heat flow
    p(th->tl) += 0
    # output force
    frc_N(pos1->pos2) += Pout
}
```

FIGURE 19

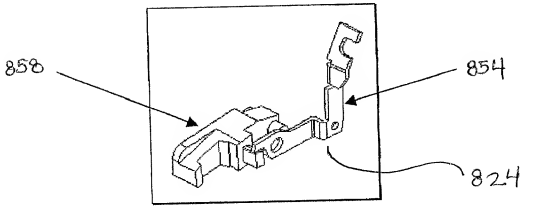


FIGURE 20

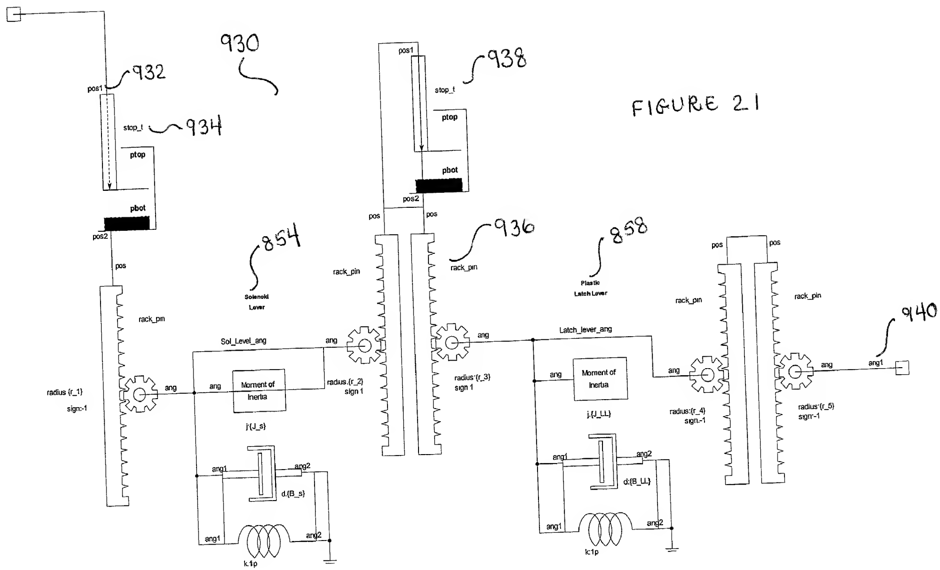
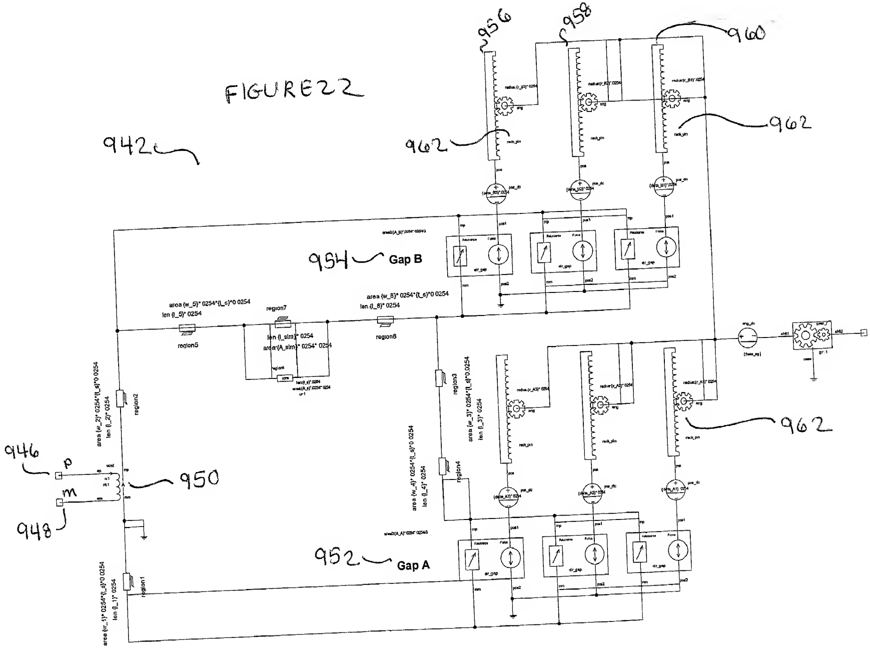

930
932
934
936
938
940
854
858
pos1
pos2
pos
stop_t
ptop
pbot
rack_pin
radius {r_1}
sign:-1
ang
Sol_Level_ang
Moment of Inertia
j:{J_s}
Solenoid Lever
radius:{r_2}
sign 1
radius:{r_3}
sign 1
ang1
ang2
d:{B_s}
k:1p
Latch_lever_ang
Plastic Latch Lever
j:{J_LL}
d:{B_LL}
radius:{r_4}
sign:-1
radius:{r_5}
sign:-1

FIGURE 21

FIGURE 22


942
946
948
950
952
954
956
958
960
962
p
m
Gap A
Gap B
region1
region2
region3
region4
region5
region6
region7
area (w_5)* 0254*(l_s)*0 0254
len (l_5)* 0254
area (w_8)* 0254*(l_s)*0 0254
len (l_8)* 0254
len (l_sim)* 0254
area*(A_sim)* 0254* 0254
area (w_2)* 0254*(l_s)*0 0254
len (l_2)* 0254
area (w_1)* 0254*(l_s)*0 0254
len (l_1)* 0254
area (w_3)* 0254*(l_s)*0 0254
len (l_3)* 0254
area (w_4)* 0254*(l_s)*0 0254
len (l_4)* 0254

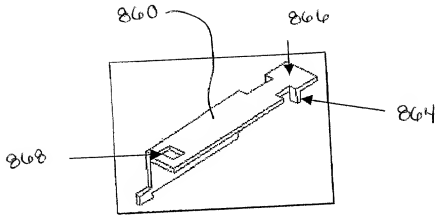


FIGURE 23

972

```
latch_pos.sin
code snippet

values {

    delta = pos_m(pos1)
    theta_op = ang_rad(ang1)

    if (delta > threshold) tq_out = 0
    else tq_out = on_torque + slope * (threshold - delta)

    # if the operating arm is already unlatched, no torque output possible.

    if ((time > 1u) & (theta_op < -5m)) tq_out = 0
}
```

FIGURE 25

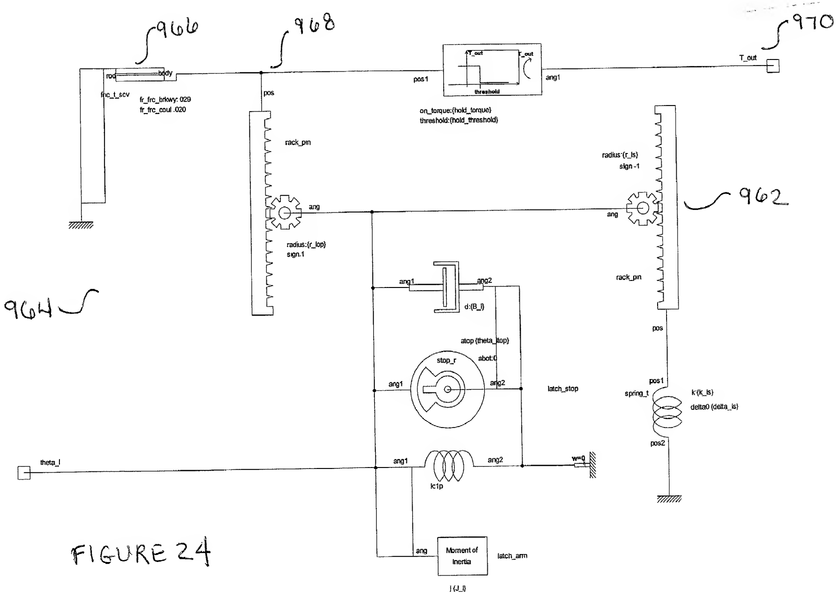
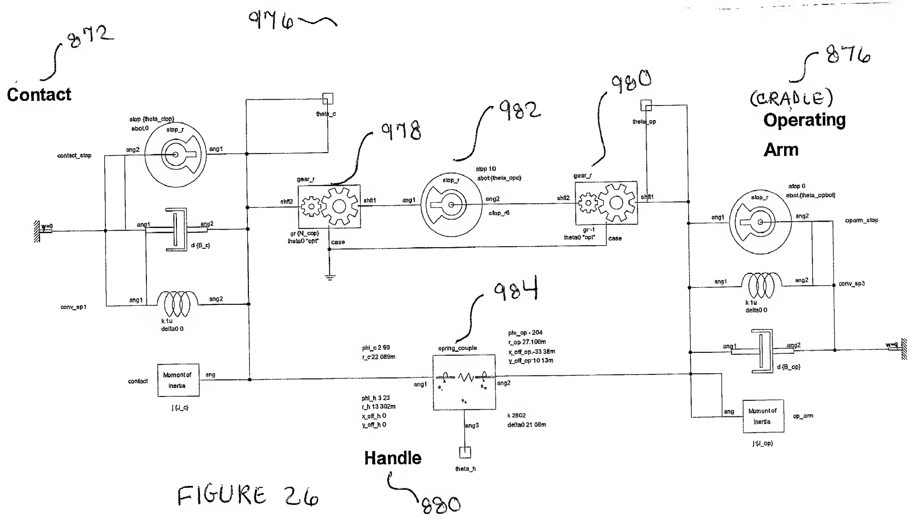

966
968
970
962
964
rod
body
frc_t_scv
fr_frc_brkwy: 029
fr_frc_coul .020
pos
rack_pin
ang
radius:{r_lop}
sign.1
pos1
T_out
threshold
ang1
on_torque:{hold_torque}
threshold:{hold_threshold}
T_out
radius:{r_ls}
sign -1
ang
rack_pin
pos
pos1
spring_t
k:{k_ls}
delta0 {delta_ls}
pos2
ang1
ang2
d:{B_l}
atop {theta_stop}
abot:0
stop_r
ang1
ang2
latch_stop
theta_l
ang1
ang2
k:1p
w=0
ang
Moment of Inertia
latch_arm
J:{J_l}

FIGURE 24



Contact
872
976
Operating Arm
(CRADLE)
876
978
982
980
984
Handle
880
theta_c
theta_op
theta_h
atop {theta_ctop}
abot 0
stop_r
ang1
ang2
contact_stop
d {B_c}
conv_sp1
k 1u
delta0 0
contact
Moment of Inertia
ang
J {J_c}
gear_r
shft1
shft2
gr {N_cop}
theta0 "opt"
case
atop 10
abot {theta_opc}
stop_r6
gr -1
spring_couple
ang3
phi_c 2 99
r_c 22 089m
phi_h 3 23
r_h 13 302m
x_off_h 0
y_off_h 0
phi_op - 204
r_op 27.106m
x_off_op -33 38m
y_off_op 10 13m
k 2802
delta0 21 08m
atop 0
abot {theta_opbot}
oparm_stop
conv_sp3
d {B_op}
op_arm
J {J_op}
w=0

FIGURE 26

984

```
spring_coupling.sin
code snippet

values {

    theta_c = ang_rad(ang1)
    theta_op = ang_rad(ang2)
    theta_h = ang_rad(ang3)

    x_cp = r_h * cos(theta_h + phi_h) + x_off_h      # calculate pivot point for contact arm
    y_cp = r_h * sin(theta_h + phi_h) + y_off_h

    x_op = r_op * cos(theta_op + phi_op) + x_off_op # calculate spring connection point
    y_op = r_op * sin(theta_op + phi_op) + y_off_op # for op arm

    x_c = r_c * cos(theta_c + phi_c) + x_cp         # calculate spring connection point
    y_c = r_c * sin(theta_c + phi_c) + y_cp         # for contact

                                                    # spring length, x
    deltax = x_op - x_c                             # & y
    deltay = y_op - y_c

    delta = sqrt(abs(deltax * deltax + deltay * deltay))       # total spring length

    x_spring_f = k * (delta - delta0) * deltax / delta  # spring force components
    y_spring_f = k * (delta - delta0) * deltay / delta


    # Calculate spring torque applied to each member - use normal radial distances to
    # spring force components.

    tq_op = x_spring_f * r_op * sin(theta_op + phi_op) + -1 * y_spring_f * r_op * cos (theta_op +
phi_op)
    tq_c = -1 * x_spring_f * r_c * sin(theta_c + phi_c) + y_spring_f * r_c * cos (theta_c + phi_c)
}
```

986

FIGURE 27

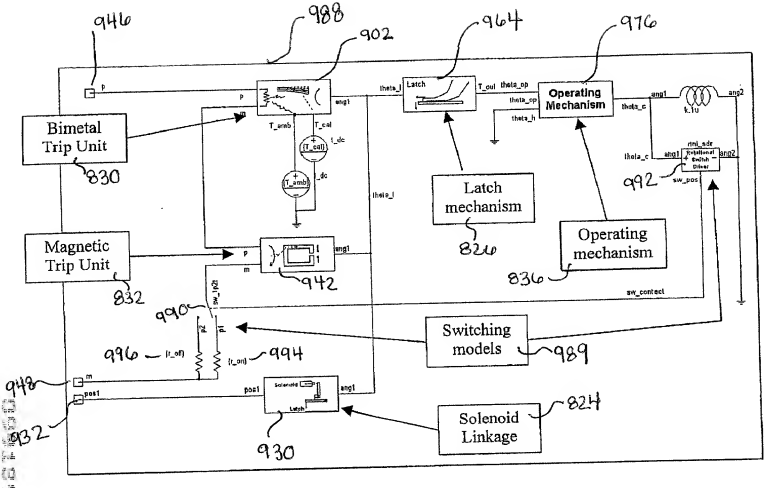


FIGURE 28

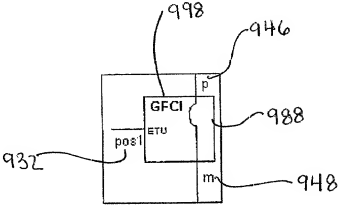


FIGURE 29

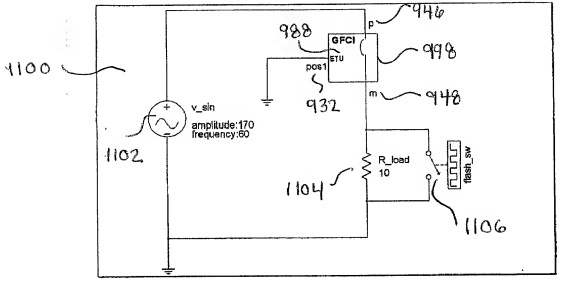


FIGURE 30

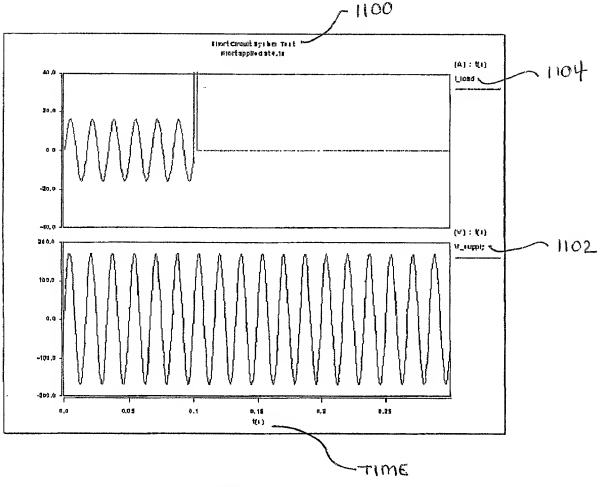


FIGURE 31

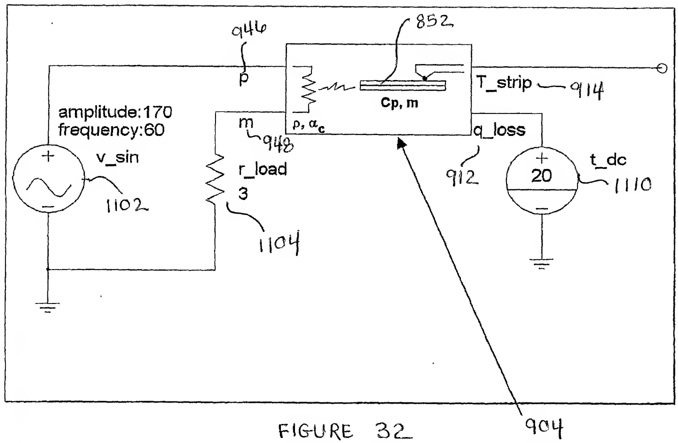


FIGURE 32

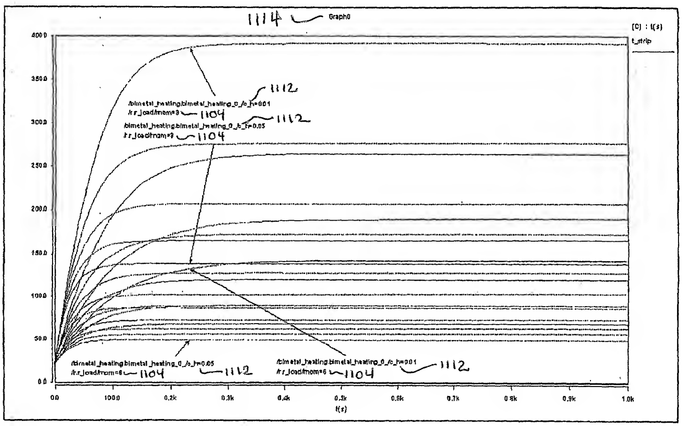
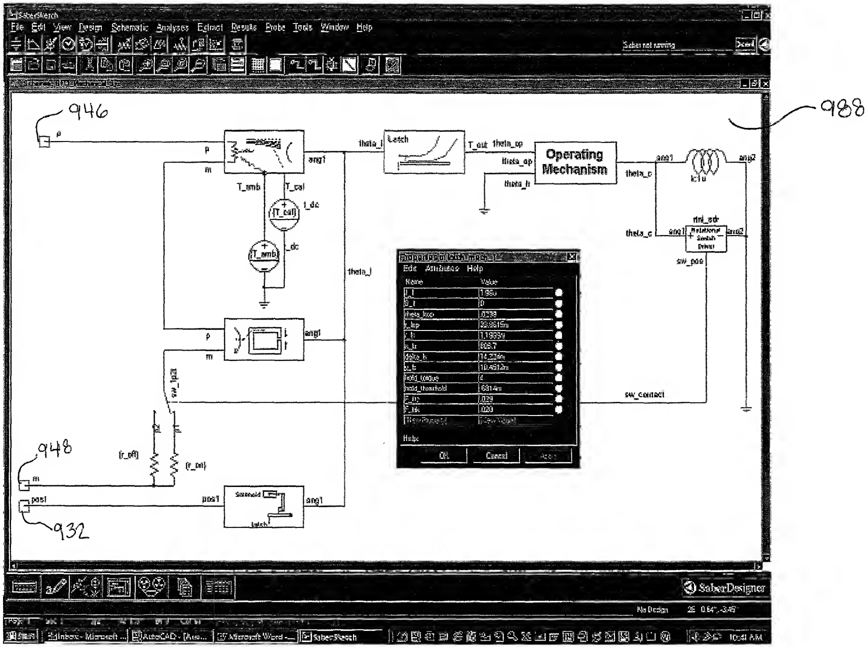


FIGURE 33



SaberSketch
File Edit View Design Schematic Analyses Extract Results Probe Tools Window Help
946
p
p
m
ang1
T_amb
T_cal
I_dc
T_cal
T_amb
theta_l
Latch
T_out
theta_op
theta_op
theta_h
Operating Mechanism
ang1
ang2
theta_c
theta_c
ang1
ang2
sw_pos
sw_contact
988
p
m
ang1
theta_l
948
m
(r_off)
(r_on)
pos1
pos1
Solenoid
latch
ang1
932
Edit Attributes Help
Name
Value
Help
OK
Cancel
SaberDesigner
No Design

FIGURE 34

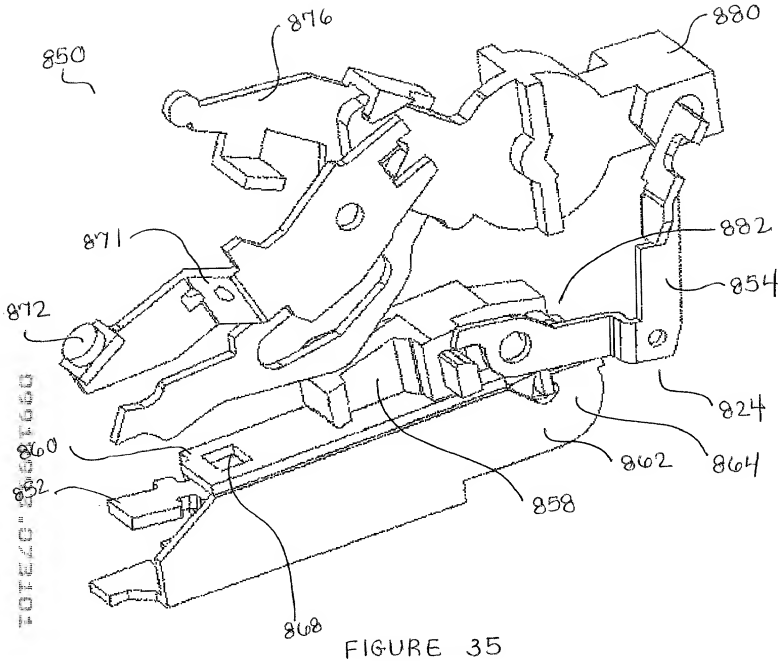


FIGURE 35